CHIPS THE DEPARTMENT OF THE NAVY'S INFORMATION TECHNOLOGY MAGAZINE

Increasing Spectrum Efficiency

By Thomas Kidd, Director Strategic Spectrum Policy, DON CIO - April-June 2016

Many forms of electromagnetic energy make up the electromagnetic environment, e.g., gamma rays, X-rays, ultraviolet radiation, visible light, infrared radiation, microwaves, and radio waves. This "energy" includes manmade emissions from communications equipment and systems, commercial systems, and electrical power lines and generators, as well as natural emissions from lightning, the sun, cosmic radiation, and other sources. Navigating this vast array of energy requires coordinated management activities across all functional areas within the Department of the Navy.

The goal of spectrum efficiency is to minimize electromagnetic environmental impact while maximizing operational effectiveness of this finite resource. The ultimate goal of spectrum users is to employ more spectrally efficient systems. Efficient use of electromagnetic spectrum is critical for future spectrum sharing. While conceptually this may seem obvious, it is not easy to understand in practice. In this article, we explore what spectrum efficiency means and what challenges exist in measuring improved efficiency.

In its simplest form, efficiency is the ratio of the output to the input of any system. For spectrum dependent digital communications systems, efficiency is sometimes measured as bits per hertz. However, other measurement ratios apply for other spectrum-dependent systems. This difference presents a unique challenge in determining which system is using spectrum most efficiently.

In some cases, we avoid this challenge because separate portions of the radio frequency spectrum are allocated for specific systems to operate. For example, certain spectrum bands are allocated for radar systems and other bands are allocated for wireless networks. But there are many other cases in which one spectrum band is allocated to multiple uses. In those situations, without a common frame of reference or measurement, it may not be possible to determine which system is more efficient.

However, while determining and comparing absolute spectrum efficiency among multiple systems might be impossible, determining relative efficiency between systems could become a viable standard procedure.

Determining relative efficiency does not necessarily require a quantitative measure of efficiency. If the general concept of spectrum efficiency is understood, two systems might be compared based on a qualitative judgment that one is more efficient than the other, without a need to actually measure efficiency. For example, a person can hold two stones, one in each hand, and determine if one is significantly heavier than the other without weighing them. This form of relative comparison (illustrated in Figure 1) could become standard.

Since all electromagnetic systems must share the electromagnetic environment, a qualitative evaluation of spectrum efficiency might be: which system is the most effective in performing its function with the least impact on the electromagnetic environment. When two systems are compared using this measure, it may be possible to determine if one system is more efficient than another without requiring a quantitative measure.

Having a method of determining which system is more efficient than another also helps to improve spectrum efficiency over time. As a new system enters a spectrum band, there could be a requirement that it assert how it is more efficient than other systems in that same band. The new system may claim to have similar capabilities but less impact on the electromagnetic environment, or greater capabilities with similar impact on the electromagnetic environment. Ideally, the new system will have both greater capabilities and less impact.

While this method may not be an ideal solution to the challenge of increasing spectrum efficiency, it is an approach that could be implemented today and into the future, whether a method ever materializes of comparing significantly different spectrum dependent systems.

Spectrum efficiency is critical to enabling greater use of this finite resource. Increasing efficiency cannot wait for a one-size-fits-all definition or quantitative measurement approach that may never emerge. It is better to generally move in the right direction than to not move at all. By qualitatively comparing new spectrum-dependent systems with current systems, there is an opportunity to increase spectrum efficiency without precisely measuring it.

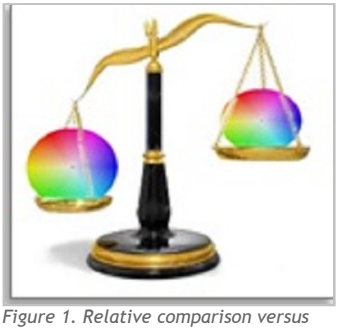

Figure 1. Relative comparison versus specific measurement.

Related CHIPS Articles

Deputy Secretary Discusses Future of Space Force at Space and Missile Systems Center

ICYMI: Artificial intelligence likely to help shape future battlefield, says Army vice chief

Junior Navy Technologists Create Autonomous Swarm Capability for Warfighters

Navy awards Boeing $805.3 million contract to design, build MQ-25A Stingray

Royal Australian Navy Delegation Visits NSWC Dahlgren Division in the Wake of RIMPAC 2018

Related DON CIO News

DON CIO Remains Focused on DON IM/IT policy and Governance Oversight

DON IT Conference Presentations Available

SECNAV Instruction 2400.2A Provides Updated DON Policy on Electromagnetic Environment Policy and Management

DON IT Conferences Share Information / Recognize DON IT Award Winners

DON CIO Publishes Cyber Glossary

Related DON CIO Policy

Electromagnetic Environmental Effects and Space Weather Event Preparedness Policy and Management

Radio Receiver Frequency Assignments for Mission-Critical Systems

DON Electromagnetic Spectrum Harmful Interference Reporting

Spectrum Supportability Risk Assessment Process Using the Spectrum Supportability Integrated Process Portal

DON Cyberspace IT and Cybersecurity

Workforce Management and Qualification Manual

Tom Kidd is the Director, DON Strategic Spectrum Policy, in the office of the Department of the Navy Chief Information Officer.

TAGS: Cybersecurity, NEN, NNE, Spectrum, Telecommunications, Wireless, Workforce

CHIPS is an official U.S. Navy website sponsored by the Department of the Navy (DON) Chief Information Officer, the Department of Defense Enterprise Software Initiative (ESI) and the DON's ESI Software Product Manager Team at Space and Naval Warfare Systems Center Pacific.

Online ISSN 2154-1779; Print ISSN 1047-9988